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FINAL REPORT

SCLEROTINIA STEM ROT-RESISTANT CANOLA FOR WESTERN CANADA

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Project Number: 97000277

Project Title: "Sclerotinia stem rot-resistant canola for western Canada"

Abstract

The objectives of the project were to produce stem rot resistant lines of Argentine (*Brassica napus*) canola and develop molecular markers associated with the resistance for marker-assisted breeding. Novel stem rot resistant lines were developed by inbreeding and doubled haploidy. Results of field tests in stem rot nurseries under heavy disease pressure showed lines with fewer than 2.5% infected plants in comparison with susceptible lines with over 45% infested plants. Lines were also derived from crosses between stem rot-resistant plants and an elite line of *B. napus* canola to improve the agronomics of the lines. Molecular marker development was undertaken.

Executive Summary

Sclerotinia stem rot, caused by the fungus *Sclerotinia sclerotiorum* (Lib.) de Bary, is endemic in western Canada and affects a large number of crop species, including Argentine canola (*Brassica napus*), Polish canola (*B. rapa*), and brown/oriental mustard (*B. juncea*). White/yellow mustard (*Sinapis alba*) is also susceptible to the disease but is less sensitive to it than brown/oriental mustard and the canola species.

There are currently no stem rot resistant cultivars of canola and brown/oriental mustard available to producers, except for the recently released apetalous *B. napus* canola cultivar HyLite 201 (Advanta Seeds). The near absence of petals in this cultivar constitutes an effective avoidance mechanism, since the main infection factor, *i.e.*, senescing petals, has been bypassed. No information on the level of genetic resistance in cv. HyLite 201 has been published.

The aim of ADF project 97000277 was to capitalise on advances made over the last two decades by breeders and plant pathologists at the Saskatoon Research Centre (AAFC-SRC). This research effort has led to the development of lines of *B. napus* rapeseed and canola segregating for stem rot resistance. The primary objective of the project was to fix the resistance and introgress it into elite *B. napus* canola germplasm. The secondary objectives were to determine

the genetics of the resistance and to develop molecular markers for marker-assisted breeding in order to speed up the identification of plants carrying genes for stem rot resistance.

To achieve these objectives, *B. napus* lines developed by AAFC-SRC and others were used. Pathogenicity tests were conducted on flowering plants raised under controlled environment conditions (growth chamber) initially using cut leaf assays and then adult plant assays. These assays required the use of senescing (7-day-old) petals infested with ascospores of an aggressive clone of the fungus (clone 321, Kohli *et al.* 1995). In all tests, cut leaves and adult plants were inoculated with petals collected on the plants that were tested. In both assays, lesion area (cut leaf assays) and stem lesion length (adult plant assays) were measured seven days after inoculation. A plant with lesions no larger than 1 cm^2 (cut leaf assays) or with stem lesions no longer than 1 cm (adult plant assays) was considered to possess a high level of resistance. The rating scale used in the adult plant assays was as follows: Resistant plants= lesions $\leq$ 1 cm long; intermediate plants= lesions > 1 cm to $\leq$ 7 cm long; susceptible plants= lesions > 7 cm long.

In the first year of the project, the segregation for stem rot resistance was confirmed in a number of lines. Resistant plants were selfed and their self-progeny was raised and assessed for stem rot resistance. In these progenies, there was a high proportion of susceptible and intermediate plants, suggesting that the trait is controlled by several genes, and may be under quantitative inheritance. In the next two years of the project, a selfing program assisted with selection for resistance was undertaken to fix the resistance in these lines. The second approach chosen to fix resistance was to develop doubled haploid lines from cultured microspores of segregating plants. Both the inbreeding and doubled haploidy work have led to the development of lines with a high level of resistance and of one doubled haploid line that is fixed for resistance.

In order to improve the agronomic performance and seed quality of the stem rot resistant lines, resistant plants were crossed reciprocally to an elite line of *B. napus* canola derived from Dr. G. Rakow's breeding program for yellow seeded canola. The elite line is susceptible to stem rot. The F_1 populations that have been examined so far are susceptible to stem rot, indicating that the resistance is conditioned by recessive gene(s). This finding implies that recombination of the resistance with all of the other agronomic and seed quality traits could be a lengthy process, requiring that large numbers of progeny plants be screened for all of the traits. Marker-assisted breeding could considerably speed up the screening, assuming that markers are available for the desired traits. Considering the time required for screening for stem rot in growth chambers (7 to 16 weeks depending on whether self- or backcross progenies are being produced on the tested plants) and the space available to perform the tests, the availability of molecular markers to identify stem rot resistant plants at an early stage (in seedlings, for instance) would be invaluable. Molecular marker development was undertaken in the last year of the project and will be completed with funding provided by AAFC-SRC.

A novel inoculation method was also designed to simplify the inoculation procedures and to obviate the need for collecting and infesting senescing petals. Results obtained with the technique were not always correlated with the results of the adult plant assays, *i.e.*, plants that were resistant when inoculated with infested petals were not always resistant when inoculated with the new method. This is possibly because, with the new method, the fungus is able to develop directly into the stem and bypasses the resistance that may be present in leaf tissue and the epidermal layers of the stem. The method hence provides a measure of the resistance of the internal tissues of the stem. The cytological events associated with growth of the fungus in the stem of resistant and susceptible plants remain to be documented.

The results obtained in the course of the project indicate that stem rot resistance can be expressed in petal tissues (usually by delaying fungal colonisation), and in leaf and stem tissues (usually by delaying or stopping fungal growth). The various resistance phenotypes may be conditioned by different genes.

Field evaluations. Selected experimental lines (selected for resistance or susceptibility to the stem rot pathogen) were tested in the AAFC-SRC's field stem rot nurseries at Saskatoon in 1999 and at Saskatoon and Melfort in 2000. In the Saskatoon nursery, natural inoculum was supplemented with apothecium-bearing sclerotia of clone 321 raised in the laboratory. No additional inoculum was required in the Melfort nursery, as natural inoculum was plentiful. Both nurseries were irrigated to maintain a high moisture level under the canopy required to promote ascospore discharge and disease development. At both sites, lines were sown in 10-foot long rows seeded 12 inches apart, 100 seeds per row. The reaction to *S. sclerotiorum* (percent of plants infected and the length of the stem lesions on each plant) was assessed at plant maturity (harvest).

In 1999, eight experimental lines were assessed, along with *B. rapa* AC Parkland, *B. napus* Crésor and Westar, *B. carinata* S67 and Dodolla, and *S. alba* AC Pennant. The nursery consisted of two replicate plots, each with seven rows of AC Parkland, one row of the *B. napus*, *B. carinata*, and *S. alba* entries, and one row of each of the experimental lines.

There was generally a higher level of stem rot infection in plot 2 than in plot 1, likely because of the denser leaf canopy in this plot, resulting in a more moist and favourable environment. Based on the values obtained in plot 2 (Table 1), the most resistant checks were Crésor (1.5% infected plants, representing 1 plant out of 66, bearing a 50 cm long lesion), S67 (3.0% infected plants, representing 1 plant out of 32, bearing a 2 cm long lesion), and AC Pennant (3.3% infected plants, average stem lesion: 12.0 cm). Westar was the most susceptible check (18.0% infected plants, average stem lesion: 25.0 cm). AC Parkland was also susceptible (10.0% infected plants, average stem lesion: 21.5 cm). Under field conditions, the resistance of Crésor could be related to its later maturity, although a genetic component does seem to exist in this cultivar, as shown by Sedun *et al.* (1989) in an adult plant assay conducted under controlled environment conditions. In this experiment, the rate of lesion development (mm/day) in plants of Crésor was significantly slower than in plants of Westar by a factor of 3.

Among the experimental lines, lines LRpl1, LRpl20, LRpl21, and LR-DH3000-7, considered to be resistant on the basis of cut leaf assays, were highly resistant in the field disease nursery with no infected plants (Table 1). Line LSPl2, which was susceptible in the cut leaf assays, was also susceptible in the field (10.3% infected plants, average stem lesion: 30.8 cm).

In 2000, 34 experimental lines were tested in Saskatoon and 29 lines in Melfort, along with *B. rapa* AC Parkland, *B. napus* Crésor, Westar, Ebony, and Hylite 201, *B. carinata* Dodolla, S67, and S71, *B. juncea* Common Brown, Cutlass, and Jubilijnaja, and *S. alba* AC Pennant. The Saskatoon nursery consisted of four replicate plots, each with 11 rows of the *B. rapa* entry and one row each of the other entries. The Melfort nursery consisted of two replicate plots, each with 11 rows of the *B. rapa* entry and one row each of the other entries.

In general, stem rot infection at Melfort was higher than at Saskatoon, providing a more accurate assessment of the lines. Based on the values obtained at Melfort (Table 2), the most resistant checks were Ebony (4.5% infected plants, average stem lesion: 14.5 cm) and Crésor (9.5% infected plants, average stem lesion: 19.0 cm). Cultivars Westar (57.1% infected plants, average stem lesion: 15.7 cm) and Hylite 201 (45.0% infected plants, average stem lesion: 16.5 cm) were the most susceptible checks. Ethiopian mustard cultivar S67, which was resistant at

Saskatoon, grew poorly at Melfort and 44.0% of the 25 plants that could be rated were highly susceptible (average stem lesion: 28.1 cm). AC Parkland was again less susceptible than Westar. Under the heavy disease pressure at Melfort, the oriental/brown mustard performed better than Westar and Hylite 201, but were more susceptible than Ebony and Crésor.

Among the experimental lines, out of five lines that were highly resistant at Saskatoon (with less than 1% infected plants), two were also highly resistant at Melfort (no infected plants), but the number of plants rated was small (Table 2). Line #20, also tested in 1999 (as line LRpl20) was resistant at Saskatoon (0.6% infected plants, representing 1 plant out of 171, bearing a 24.0 cm long lesion) and was similar to Crésor in the Melfort nursery (11.4% infected plants, average lesion length: 5.0 cm). Further evaluation of the experimental lines will be performed at both sites in 2001 to confirm the stem rot ratings.

The results obtained under controlled environment and field conditions mostly agreed, but sometimes varied. This is possibly due to the fact that a single clone of the fungus was used for the experiments in controlled environment conditions, while the plants grown in the field nurseries where subjected to the clones present at the sites.

Other diseases and pests. Blackleg severity, alternaria black spot severity on siliques, and the incidence of aster yellows were recorded in 1999 and 2000 to obtain preliminary information on the disease resistance potential of the lines. The incidence of root maggots was also noted in 2000. Procedural details are described in Progress Report 3 (December 31, 1999).

Blackleg, alternaria black spot, and aster yellows. In 1999, some of the lines selected for stem rot resistance, *e.g.*, LR-DH3000-7, appeared to have some blackleg resistance (Table 3). In 2000, however, blackleg severity was low, even on entries known to be susceptible to the disease, *e.g.*, Westar, whose reaction to blackleg was similar to that of resistant material, *e.g.*, the mustards (Table 4), and no meaningful conclusions could be drawn. Blackleg assessment of the lines will be performed in one of AAFC-SRC's field blackleg nurseries in 2001.

Alternaria black spot incidence was high on some lines in 1999, but severity on siliques was generally low in both years. In 1999, among checks, black spot incidence was the lowest on Crésor (no infected plants) and the highest on Westar (average: 76.4%). The resistance in Crésor may be due to the lateness of the cultivar under Saskatchewan growing conditions. Crésor also possesses a thick epicuticular wax layer. This trait has been found to be involved in black spot resistance (Conn *et al.* 1984; Skoropad and Tewari 1977; Tewari and Skoropad 1976). Alternaria black spot incidence on the *B. napus* experimental lines ranged from 0 to 64.7%, but severity on siliques was low. Whether the incidence differences among lines have a genetic basis remains to be determined.

Aster yellows disease is caused by leafhopper-transmitted phytoplasmas. There is little information in the literature on the degree of resistance to aster yellows of *Brassica* and *Sinapis* species. The weather conditions in 1999 were favourable to the appearance of aster yellows and some of the lines were affected. For instance, up to 10% of the AC Parkland plants showed aster yellows symptoms. In 2000, the incidence of aster yellows in the Saskatoon nursery was low, with 73.5% of the lines with less than 5% infected plants. At Melfort, the incidence of aster yellows was slightly higher, but 59.2% of the lines had less than 10% infected plants. Again, as with alternaria black spot, it remains to be seen whether the differences observed among lines have a genetic basis.

Root maggots. The incidence of root maggots was examined in the 2000 nurseries (Table 4). None of the checks and the experimental lines were free of root maggots in the Saskatoon

nursery (range: 7.0% to 27.6% infected plants among checks and 9.3% to 29.4% infected plants among the experimental lines). Root maggots were not as frequently observed at Melfort and several experimental lines were free of the pests.

Seed quality of the *B. napus* experimental lines with a high level of stem rot resistance under field conditions. Research efforts during the project were focussed on developing lines with a high level of stem rot resistance. In order for these lines to become relevant to the canola industry, they must meet canola quality standards for glucosinolate and erucic acid content and possess an acceptable seed oil content, fatty acid profile, and protein content. Analyses for these traits are in progress on seed harvested in the 2000 field nurseries. This information will provide a basis to narrow the number of lines for further breeding.

Ascospore storage study. Ascospore production in the laboratory is labour and time consuming, but is a necessary step to provide inoculum for screening plants. In order to reduce the amount of time devoted to this activity, we developed a method to stock ascospores for use in the pathogenicity tests. The results of the study indicated that viable and infectious ascospores can be stored at –20°C and –80°C in 30 to 60% aqueous glycerol solutions, for up to 12 months. A manuscript describing the results will be submitted for publication in a scientific journal in 2001.

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1) Dr. C.Y. Lefol was hired to work on the project because of her broad expertise in plant pathology, including sclerotinia stem rot research.

2) L. Commerçon and L. Gelay-Turtaut were students from the Université Claude Bernard, Lyon, France. As a requirement for completion of their degree, Ms. Commerçon and Mr. Gelay-Turtaut were required to perform an 8 to 9-month training period in a government or industrial laboratory, either in France or abroad.

3) D. Zhang was a Grade 12 student (Evan Hardy Collegiate, Saskatoon) participating in the Saskatoon Board of Education Work Education Program (100 hours).

4) S. Pooler was an AAFC-SRC FSWEP student. Ms. Pooler assisted Dr. Lefol with the field nurseries and some of the growth chamber experiments.

5) K. Schoneberg was a Grade 11 student (Evan Hardy Collegiate, Saskatoon) participating in the Saskatoon Board of Education Work Education Program (>100 hours).

6) AAFC-SRC Research Technicians. T. Bundrock and S. Rooke provided assistance in the production of the doubled haploid lines; D. Rode and J. Relf-Eckstein set up and sowed the 1999 and 2000 field nurseries and assisted with plot maintenance at Saskatoon; Dr. R. Kutcher's staff, AAFC-SRC's Melfort Experimental Farm, assisted with plot maintenance at Melfort.

Project Developed Materials

Plant material

1. Stem rot resistant *B. napus* experimental lines.
2. Stem rot resistant and susceptible doubled haploid *B. napus* lines.
3. Progenies of stem rot resistant *B. napus* lines x a stem rot susceptible elite *B. napus* canola line).

Publications

Lefol, C., and Séguin-Swartz, G. 1999. Storage procedures for ascospores of *Sclerotinia sclerotiorum*. Proceedings of the 10th International Sclerotinia Workshop, 9-12 September 1998, Fargo, USA. pp. 24-25.

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Table 1. Reaction of cultivars and lines of *Brassica* species and *Sinapis alba* in the 1999 field stem rot nursery at Saskatoon (1 row/plot and entry). Number of plants rated, percent infected plants, mean stem lesion length per infected plant, and mean stem lesion length for 10 plants/row inoculated with the new inoculation method.

Entry	Plot 1				Plot 2			
	No. of plants rated	%Infected plants	Lesion (cm±s.d.)	New inoc.	No. of plants rated	%Infected plants	Lesion (cm±s.d.)	New inoc.
Brassica napus Crésor	60	0	0	3.0±2.2	66	1.5	50[b]	4.0±1.3
Westar	44	6.8	5.5±4.6	4.3±1.7	38	18.0	25.0±13.0	4.0±1.8
LRpl1	56	0	0	2.8±2.0	61	0	0	6.7±1.7
LRpl17	68	0	0	2.5±1.2	64	7.0	24.0±10.0	4.4±0.7
LRpl19	69	0	0	2.9±1.7	44	2.2	16[a]	4.8±1.7
LRpl20	66	0	0	0.7±0.5	69	0	0	0.9±1.1
LRpl21	49	0	0	2.5±1.6	58	0	0	5.6±0.7
LR-DH3000-7	52	0	0	0.3±0.5	29	0	0	1.0±1.6
LSpl2	56	0	0	0.7±0.8	77	10.3	30.8±15.0	4.1±1.6
LS-DH3001-13	35	0	0	n.d.	4	0	0	2.6±1.1
B. rapa AC Parkland	227[b]	7.0	22.0±12.4	4.5±1.8	199[b]	10.0	21.5±9.8	3.8±1.0
B. carinata S67	29	6.8	0.8±0.3	2.7±1.1	32	3.0	2[a]	4.0±0.6
Dodolla	42	0	0	0.6±0.5	30	6.0	8.7±6.0	n.d.
Sinapis alba AC Pennant	72	0	0	3.6±0.8	60	3.3	12.0±8.0	7.0±0.7

[a]One infected plant.
[b]7 rows.
n.d.= not determined.

Table 2. Reaction of cultivars and lines of *Brassica* species and *Sinapis alba* in the 2000 field stem rot nurseries at Saskatoon (3 rows/entry) and Melfort (2 rows/entry). Number of plants rated, percent infected plants, mean stem lesion length per infected plant, and mean stem lesion length for 20 plants/row inoculated with the new inoculation method.

Species Cultivar/line	Saskatoon				Melfort			
	No. plants rated	%Infected plants	Lesion (cm±s.d.)	New inoc. (cm±s.d.)	No. plants rated	%Infected plants	Lesion (cm±s.d.)	New inoc. (cm±s.d.)
Brassica carinata								
Dodolla	177	11.3	17.0±8.2	5.5±1.2	62	41.9	24.2±19.6	3.7±1.5
S67	158	6.3	9.1±6.9	4.7±1.3	25	44.0	28.1±22.4	4.2±1.5
S71	145	7.6	16.5±10.5	6.5±1.3	54	27.8	24.8±19.9	3.8±1.3
Brassica juncea								
Comm. Brown	179	6.7	20.7±20.0	5.4±2.1	117	29.9	19.2±12.4	5.0±1.7
Cutlass	148	6.8	8.2±5.6	6.0±2.2	121	16.5	18.4±20.7	5.3±1.6
Jubilijnaja	138	6.5	11.2±9.3	5.5±1.8	70	22.9	19.6±9.8	5.3±1.7
Brassica napus								
Crésor	148	4.7	5.7±4.6	7.0±2.6	41	9.5	19.0±11.0	3.0±1.2
Ebony	152	3.9	14.1±6.3	5.5±1.9	55	4.5	14.5±17.7	4.2±1.2
Hylite 201	130	7.7	14.1±7.9	5.7±1.8	40	45.0	16.5±9.2	5.3±1.2
Westar	159	14.5	14.5±8.8	6.3±1.8	56	57.1	15.7±9.6	4.8±1.5
DH3000-11	125	0.8	30.0[a]	4.0±1.7	25	0		4.3±1.6
DH3001-5	89	7.9	20.7±11.8	7.0±2.5	72	6.9	12.2±7.9	4.6±1.9
DH3001-40	165	3.0	23.6±11.3	5.7±2.5	53	5.7	17.3±6.5	2.9±1.5
DH14603	143	3.5	25.4±6.4	4.4±1.5	22	63.6	27.4±16.9	3.6±1.1
DH14608	122	9.0	19.5±9.3	6.0±2.0	35	48.6	16.2±8.1	4.8±1.3
YN94-673	138	7.2	9.1±8.0	4.3±1.7	25	48.0	35.3±23.0	3.2±3.3
Lin#1	180	3.9	10.9±7.2	4.1±1.3	15[b]	0		2.8±1.2
Lin#2	177	3.4	10.0±10.6	4.7±1.7	75	21.3	20.1±11.0	4.2±1.4
Lin#5	159	15.7	16.5±11.0	3.8±1.3	3	0		3.6±2.0
Lin#7	217	0		4.1±1.2				
Lin#9	140	2.1	8.2 ±6.0	5.7±1.9	55	21.8	12.8±9.5	3.1±1.0
Lin#11	174	4.0	14.6±7.6	4.7±1.7	40	7.5	10.3±1.5	4.3±1.4
Lin#20	171	0.6	24.0[a]	4.6±2.2	35[b]	11.4	5.0±2.7	4.2±1.6

Table 2 (continued)

Species Cultivar/line	Saskatoon				Melfort			
	No. plants rated	%Infected plants	Lesion (cm±s.d.)	New inoc. (cm±s.d.)	No. plants rated	%Infected plants	Lesion (cm±s.d.)	New inoc. (cm±s.d.)
Brassica napus (continued)								
Lin#21	152	1.3	4.5±2.1	3.7±1.5				
Lin1#9	152	1.3	14.5±13.4	3.0±1.7	37	16.2	15.5±6.1	4.1±1.1
Lin1#21	192	2.1	9.0±6.7	5.0±1.5	23	0		3.0±1.5
Lin2#8	182	4.9	9.4±10.0	3.8±2.6	22[b]	0		4.1±1.1
Lin2#10	183	2.2	18.0±15.0	4.8±1.8	46	45.7	20.9±12.5	4.3±1.2
Lin2#12	187	5.9	16.6±11.3	5.9±2.1	50	14.0	11.4±8.6	4.3±0.9
Lin7#1	85	2.4	12.0±15.9	5.9±1.8				
Lin7#2	151	1.3	5.0±5.7	3.2±1.7	38	10.5	19.0±14.7	3.2±1.3
Lin7#3	137	1.5	20.5±13.4	6.3±1.5				
Lin9#4	183	0.5	15.0[a]	4.5±1.4	35	0		3.4±0.8
Lin9#5	162	3.1	15.8±13.8	5.4±2.0	65	15.4	14.2±10.1	3.9±1.4
Lin9#7	150	0.7	21.0[a]	5.0±1.9	22	0		3.9±1.5
Lin9#10	160	0		5.6±2.0	48	15.9	8.3±9.0	4.1±1.2
Lin20#3	185	4.3	11.8±13.3	4.0±1.5	9[b]	11 1	7.0[a]	3.8±0.8
Lin20#8	154	3.2	17.2±12.0	5.9±1.9	17	5.9	8.0[a]	5.2±1.6
Lin20#11	185	3.8	13.7±8.7	5.3±1.8	48	27.1	15.0±9.0	3.9±1.3
Lin20#23	164	3.7	14.7±20.8	3.8±1.3	33	6.1	30.0[a]	3.9±1.4
Lin21#2	157	1.9	19.0±1.4	4.8±2.2	15	0		3.6±1.2
Lin21#5	17[a]	0		2.0±0.0				
Lin21#6	187	4.3	12.6±7.1	4.5±1.4	86	27.9	19.5±13.3	4.2±1.3
Lin21#12	158	4.4	13.4±7.8	5.6±1.6	22	9.1	24.0±7.1	3.7±1.8
Brassica rapa								
AC Parkland	1089[c]	10.5	26.0±2.0	6.3±2.8	301[d]	27.2	14.7±6.6	6.2±1.8
Sinapis alba								
AC Pennant	197	1.5	22.0±13.9	6.5±1.8	23[b]	17.4	15.3±10.7	7.7±2.4

[a]One infested plant. [b]1 row. [c]33 rows. [d]22 rows.

Table 3. Blackleg severity, alternaria black spot incidence and severity, and incidence of aster yellows in the 1999 field stem rot nursery at Saskatoon (1 row/plot and entry).

Entry	Plot 1				Plot 2			
	No. of plants rated	Blackleg severity	Black spot inc / sev (% / %)	Aster yellows (%)	No. of plants rated	Blackleg severity	Black spot inc / sev (% / %)	Aster yellows (%)
Brassica napus Crésor	60	0.05	0 / 0	8.3	66	1.16	0 / 0	10.6
Westar	44	1.27	81.8 / 10	0	38	0.92	71.0 / 10	0
LRpl1	56	2.10	30.4 / 1	5.3	61	1.77	63.0 / 1	1.0
LRpl17	68	0.79	64.7 / 10	0	64	1.95	20.3 / 1	0
LRpl19	69	0.95	39.1 / 1	4.0	44	0.68	97.7 / 1	0
LRpl20	66	0.62	12.1 / 1	3.0	69	1.05	42.0 / 1	0
LRpl21	49	0.69	28.5 / 10	2.0	58	0.43	13.8 / 1	3.0
LR-DH3000-7	52	0.11	0 / 0	0	29	0	0 / 0	0
LSpl2	56	0.64	57.1 / 1	3.5	77	0.96	36.4 / 5	0
LS-DH3001-13	35	0	0 / 0	0	4	0.50	0 / 0	0
B. rapa AC Parkland	227[a]	1.62	61.0 / 10	10.0	199[a]	1.60	64.3 / 10	2.5
B. carinata S67	29	0.20	17.2 / 1	0	32	0.06	0 / 0	0
Dodolla	42	0.14	9.5 / 1	2.3	30	0.16	6.7 / 1	0
Sinapis alba AC Pennant	72	0.13	8.3 / 1	2.7	60	0.16	1.7 / 1	1.6

[a]7 rows.

Table 4. Blackleg severity, alternaria black spot severity on siliques, percent of plants with aster yellows, and percent of plants with root maggots in cultivars and lines of *Brassica* species and *Sinapis alba* in the 2000 field stem rot nurseries at Saskatoon (3 rows/entry) and Melfort (2 rows/entry).

Species Cultivar/line	Saskatoon					Melfort				
	No. plants rated	Blackleg severity	Altern. severity	%Aster yellows	%Root maggots	No. plants rated	Blackleg severity	Altern. severity	%Aster yellows	%Root maggots
Brassica carinata										
Dodolla	177	0.2	0-5%	5.7	27.6	62	0.2	0%	19.0	45.3
S67	158	0.3	1-10%	3.3	27.3	25	0.2	0%	15.1	0.0
S71	145	0.3	0-10%	3.9	25.5	54	0.1	0%	21.2	7.9
Brassica juncea										
Comm. Brown	179	0.5	0-5%	1.7	13.3	117	0.1	0%	26.5	1.1
Cutlass	148	0.2	0-1%	2.7	7.0	121	0.1	1%	12.4	0.9
Jubilijnaja	138	0.3	0-1%	0.6	10.9	70	0.2	0%	7.7	1.8
Brassica napus										
Crésor	148	0.3	0-5%	4.9	10.7	41	0.3	0%	21.9	6.8
Ebony	152	0.5	0-5%	1.2	9.8	55	0.9	0-5%	0.0	4.5
Hylite 201	130	0.7	1-10%	3.4	18.3	40	0.2	1-5%	0.0	9.6
Westar	159	0.5	0-5%	1.2	12.0	56	0.8	0-10%	0.0	12.8
DH3000-11	125	0.2	0%	0.0	19.2	25	0.0	0%	0.0	0.0
DH3001-5	89	0.4	0%	3.9	22.0	72	0.3	0%	0.0	7.1
DH3001-40	165	0.3	0%	0.6	15.4	53	0.2	0%	0.0	6.6
DH14603	143	0.4	1-5%	0.6	14.5	22	0.6	0%	0.0	0.0
DH14608	122	0.3	0-10%	3.7	14.0	32	0.4	0%	0.0	1.7
YN94-673	138	0.3	1-5%	2.4	23.0	25	0.8	0-10%	0.0	19.5
Lin#1	180	0.8	0-5%	4.3	19.7	15[a]	0.5	1-5%	0.0	26.6
Lin#2	177	0.6	0-1%	0.5	11.4	75	1.8	0%	4.2	4.2
Lin#5	159	0.5	1-10%	6.3	15.3	3	2.3	0%	0.0	0.0
Lin#7	217	0.8	0-5%	3.4	25.2					
Lin#9	140	0.5	1-5%	3.4	10.9	55	1.4	0-5%	0.0	7.9
Lin#11	174	0.9	0-1%	0.5	10.4	40	3.3	0-5%	0.0	7.2
Lin#20	171	0.9	0-1%	6.5	15.0	35[a]	0.8	0%	8.5	0.0
Lin#21	152	0.9	0-5%	9.7	18.2					
Lin1#9	152	0.6	0-5%	1.3	19.3	37	1.5	1-5%	0.0	4.3
Lin1#21	192	0.6	0-5%	2.0	19.0	23	0.5	0%	10.2	0.0
Lin2#8	182	1.0	1-5%	1.7	27.6	22[a]	1.3	0%	0.0	18.1
Lin2#10	183	0.7	0-5%	1.0	15.3	46	1.2	0%	0.0	0.0
Lin2#12	187	1.0	0-5%	2.0	15.1	50	0.9	1-5%	0.0	4.0
Lin7#1	85	0.7	0-5%	6.9	29.4					
Lin7#2	151	0.7	0-5%	10.8	20.1	47	1.1	0%	5.4	0.0

Table 4 (continued)										
Species Cultivar/line	Saskatoon					Melfort				
	No. plants rated	Blackleg severity	Altern. severity	%Aster yellows	%Root maggots	No. plants rated	Blackleg severity	Altern. severity	%Aster yellows	%Root maggots
Brassica napus (continued)										
Lin7#3	137	0.6	0%	5.2	9.3					
Lin9#4	183	0.5	0%	3.8	17.1	35	0.5	0%	11.3	0.0
Lin9#5	162	0.6	0-5%	5.9	17.4	65	1.3	0-5%	7.7	7.7
Lin9#7	150	0.8	0-5%	6.0	20.5	22	0.7	0%	44.6	8.3
Lin9#10	160	0.8	0-1%	2.5	23.2	48	1.3	0-5%	0.0	24.6
Lin20#3	185	0.6	0-5%	3.7	10.5	9[a]	1.0	0%	22.0	33.3
Lin20#8	154	0.6	0-5%	4.1	12.9	17	1.1	0-1%	4.5	0.0
Lin20#11	185	0.8	0-5%	2.9	19.0	48	2.0	0-5%	4.1	10.4
Lin20#23	164	0.5	0-5%	0.8	14.2	33	1.0	1-5%	6.7	5.6
Lin21#2	157	0.6	0-1%	1.4	14.2	15	0.9	0%	20.8	4.2
Lin21#5	17[a]	0.7	5%	0.0	23.5					
Lin21#6	187	0.8	0-5%	3.1	17.5	86	1.3	1-5%	2.4	0.0
Lin21#12	158	0.5	0-5%	7.2	20.0	22	1.4	0-10%	10.0	0.0
Brassica rapa										
AC Parkland	1089[b]	1.3	1-5%	3.3	15.1	301[c]	1.8	0-10%	8.4	0.4
Sinapis alba										
AC Pennant	197	0.1	0%	9.4	8.7	23[a]	0.3	0%	26.0	13.0

[a]1 row.
[b]33 rows.
[c]22 rows.